UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007

April 2007

ZCA 101/4 - Physics I (Mechanic)
[Fizik I (Mekanik)]

Duration: 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **ELEVEN** printed pages before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEBELAS** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instruction: Answer all **FIVE** questions. Students are allowed to answer all questions in Bahasa Malaysia or in English.

*[**Arahan**: Jawab kesemua **LIMA** soalan. Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

1 (i) U.S. is a country with the highest debt in the world. In 2004, the U. S. national debt is about USD6 trillion. (a) If payments were made at the rate of USD1 000 per second, how many years would it take to pay off the debt, assuming no interest were charged? (b) A dollar bill is about 15.5 cm long. If six trillion dollar bills were laid end to end around the Earth's equator, how many times would they encircle the planet? Take the radius of the Earth at the equator to be 6378 km.

[U.S. adalah sebuah negara yang paling banyak berhutang. Dalam 2004, hutang negara ini mencecah USD6 trillion. (a) Jika pembayaran semula dibuat pada kadar USD1 000 per saat, berapa tahun diperlukan untuk membayar kesemua hutang (anggap bahawa tiada faedah dikenakan)? (b) Wang 1 dollar mempunyai panjang 15.5cm. Jika wang sebanyak USD6 trillion diatur sepanjang garisan khatulistiwa, berapa kali mereka mengelilingi bumi?. Ambil jejari bumi pada garisan khatulistiwa sebagai 6378km.]

(15/100)

(ii) One cubic meter (1.00 m^3) of aluminum has a mass of 2.70×10^3 kg, and 1.00 m^3 of iron has a mass of 7.86×10^3 kg. Find the radius of a solid aluminum sphere that will balance a solid iron sphere of radius 2.00 cm on an equal-arm balance.

[Satu meter kuib (1.00m^3) aluminium mempunyai jisim 2.70×10^3 kg, dan 1.00 m^3 besi berjisim 7.86×10^3 kg. Dapatkan jejari sfera aluminium pejal yang akan mengimbangi sfera pejal besi berjejari 2.00cm di atas suatu penimbang.]

(15/100)

(iii) A high fountain of water is located at the center of a circular pool as in Figure 1. Not wishing to get his feet wet, a student walks around the pool and measures its circumference to be 15.0 m. Next, the student stands at the edge of the pool and uses a protractor to gauge the angle of elevation of the top of the fountain to be 55.0°. How high is the fountain?

[Suatu pancutan air terletak di tengah kolam bulat seperti dalam Rajah 1. Seorang pelajar berjalan sekeliling kolam dan mengukur lilitan kolam sebagai 15.0m. Kemudian dia berdiri di pinggir kolam dan mengukur sudut dongakan yang dibuat oleh puncak pancutan dengan garis mendatar tempat dia berdiri sebanyak 55.0°. Berapakah tinggi pancutan air itu?]

(10/100)

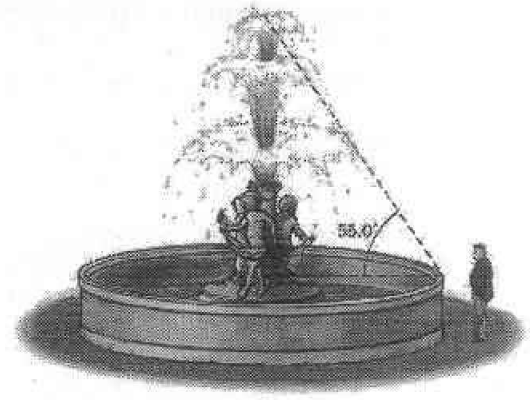

Figure 1 *[Rajah 1]*

(iv) A student throws a set of keys vertically upward to her sorority sister, who is in a window 4.00 m above. The keys are caught 1.50 s later by the sister's outstretched hand. (a) With what initial velocity were the keys thrown? (b) What was the velocity of the keys just before they were caught?
[Seorang pelajar membaling suatu set kunci secara menegak ke atas kepada kakaknya yang sedang berada pada tingkap rumah setinggi 4.00m. Set kunci ditangkap oleh kakaknya 1.50 saat kemudian. (a) Apakah halaju awal kunci yang dibaling? (b) Apakah halaju kunci sebelum ia ditangkap?]
(20/100)

(v) The speed of a bullet as it travels down the barrel of a rifle toward the opening is given by $v = (-5.00 \times 10^7)t^2 + (3.00 \times 10^5)t$, where v is in meters per second and t is in seconds. The acceleration of the bullet just as it leaves the barrel is zero. (a) Determine the acceleration and position of the bullet as a function of time when the bullet is in the barrel. (b) Determine the length of time the bullet is accelerated. (c) Find the speed at which the bullet leaves the barrel. (d) What is the length of the barrel?
[Halaju suatu peluru melalui laras senapang menuju muncung senapang diberi sebagai $v = (-5.00 \times 10^7)t^2 + (3.00 \times 10^5)t$*, di mana v dalam meter per saat dan t dalam saat. Pecutan peluru sebelum meninggalkan muncung senapang adalah sifar. (a) Tentukan pecutan dan kedudukan peluru sebagai fungsi masa apabila peluru masih di dalam laras. (b) Tentukan tempoh masa peluru dipecut di dalam laras. (c) Cari laju peluru semasa di muncung senapang. (d) Apakah panjang laras?]*
(40/100)

2. (i) If $\mathbf{A} = \left(6.00\hat{\mathbf{i}} - 8.00\hat{\mathbf{j}}\right)$ units, $\mathbf{B} = \left(-8.00\hat{\mathbf{i}} + 3.00\hat{\mathbf{j}}\right)$ units, and $\mathbf{C} = \left(26.0\hat{\mathbf{i}} + 19.0\hat{\mathbf{j}}\right)$ units,

determine a and b such that $a\mathbf{A} + b\mathbf{B} + \mathbf{C} = 0$.

[Jika $\mathbf{A} = \left(6.00\hat{\mathbf{i}} - 8.00\hat{\mathbf{j}}\right)$ *units,* $\mathbf{B} = \left(-8.00\hat{\mathbf{i}} + 3.00\hat{\mathbf{j}}\right)$ *units, dan* $\mathbf{C} = \left(26.0\hat{\mathbf{i}} + 19.0\hat{\mathbf{j}}\right)$ *units, tentukan a dan b di mana* $a\mathbf{A} + b\mathbf{B} + \mathbf{C} = 0$*].*

(20/100)

(ii) In Figure 2 a spider is resting after starting to spin its web. The gravitational force on the spider is 0.150 newton down. The spider is supported by different tension forces in the two strands above it, so that the resultant vector force on the spider is zero. The two strands are perpendicular to each other, so we have chosen the x and y directions to be along them. The tension T_x is 0.127 newton. Find (a) the tension T_y, (b) the angle the x axis makes with the horizontal, and (c) the angle the y axis makes with the horizontal.

[Dalam Rajah 2, seekor labah-labah berehat pada sarangnya. Daya graviti pada lebah ialah 0.150 newton ke bawah. Lebah disokong oleh dua tetali sarang dengan tegangan berbeza, supaya daya vektor paduan ke atas labah-labah adalah sifar. Talian sarang berserenjang antara satu sama lain, mengikut arah x dan y. Tegangan T_x *ialah 0.127 newton. Cari (a) tegangan* T_y*, (b) sudut yang dibuat paksi x dengan ufukan, dan (c) sudut dibuat oleh paksi y dengan ufukan.]*

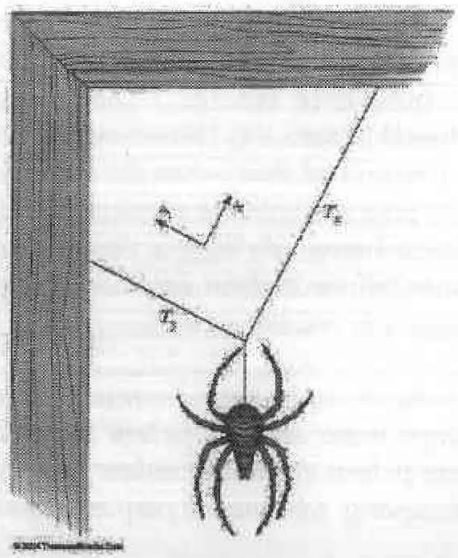

Figure 2 *[Rajah 2]*

(30/100)

(iii) A soccer player kicks a rock horizontally off a 40.0-m high cliff into a pool of water. If the player hears the sound of the splash 3.00 s later, what was the initial speed given to the rock? Assume the speed of sound in air to be 343 m/s.
[Seorang pemain bolasepak menyepak seketul batu secara mendatar dari tebing setinggi 40.0m ke dalam kolam air. Jika pemain ini mendengar bunyi batu ke dalam air 3.00 saat kemudian, apakah laju awal batu? Anggap laju bunyi di dalam udara sebagai 343m/s.]

(25/100)

(iv) The astronaut orbiting the Earth in Figure 3 is preparing to dock with a Westar VI satellite. The satellite is in a circular orbit 600 km above the Earth's surface, where the free-fall acceleration is 8.21 m/s^2. Take the radius of the Earth as 6400 km. Determine the speed of the satellite and the time interval required to complete one orbit around the Earth.
[Seorang astronaut mengelilingi bumi dalam Rajah 3 sedang bersedia untuk berlabuh pada satelit Westar VI. Satelit ini bergerak dalam orbit 600 km dari permukaan bumi, di mana pecutan jatuh-bebas ialah 8.21 m/s^2. Ambil jejari bumi sebagai 6400 km. Tentukan laju satelit dan tempoh masa diperlukan untuk menyempurnakan satu pusingan lengkap mengelilingi bumi.]

(25/100)

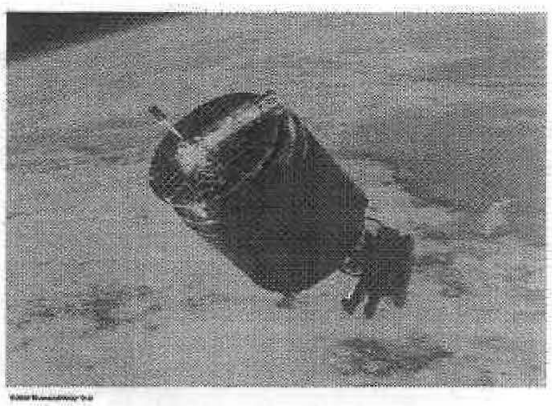

Figure 3 *[Rajah 3]*

3. (i) A car is traveling at 50.0 km/h on a horizontal highway. (a) If the coefficient of static friction between road and tires on a rainy day is 0.100, what is the minimum distance in which the car will stop? (b) What is the stopping distance when the surface is dry and $\mu_s = 0.600$?
[Sebuah kereta bergerak pada 50.0 km/jam di atas lebuhraya yang datar. (a) Jika pekali geseran statik di antara tayar dan jalanraya pada hari hujan ialah 0.100, apakah jarak minimum kereta akan berhenti? (b) Apakah jarak minimum kereta berhenti pada hari panas di mana $\mu_s = 0.600$?]

(15/100)

(ii) A motorboat cuts its engine when its speed is 10.0 m/s and coasts to rest. The equation describing the motion of the motorboat during this period is $v = v_i e^{-ct}$, where v is the speed at time t, v_i is the initial speed, and c is a constant. At t = 20.0 s, the speed is 5.00 m/s. (a) Find the constant c. (b) What is the speed at t = 40.0 s? (c) Differentiate the expression for $v(t)$ and thus show that the acceleration of the boat is proportional to the speed at any time.

[Sebuah bot mematikan enjinnya apabila lajunya 10.0m/s dan meluncur dengan sendiri sehingga ianya berhenti. Persamaan yang menerangkan pergerakan bot semasa tempoh peluncuran bebas ini diberi sebagai $v = v_i e^{-ct}$*,di mana v ialah laju pada masa t,* v_i *laju awal, dan c pemalar. Apabila t=20.0saat, laju ialah 5.00m/s. (a) Cari pemalar c. (b) Apakah laju pada t=40.0 s? (c) Kerbedakan persamaan yang diberi dan tunjukkan bahawa pecutan bot berkadar dengan laju pada sebarang masa.]*

(30/100)

(iii) A 4.00-kg particle is subject to a total force that varies with position as shown in Figure 4. The particle starts from rest at x = 0. What is its speed at (a) x = 5.00 m, (b) x = 10.0 m, (c) x = 15.0 m?

[Suatu zarah berjisim 4.00 kg dikenakan jumlah daya yang berubah dengan kedudukan ditunjukkan dalam Rajah 4. Zarah bermula dari rehat pada x=0.

Apakah laju zarah pada (a) x=5.00m, (b) x=10.0m, (c) x=15.0 m?]

(15/100)

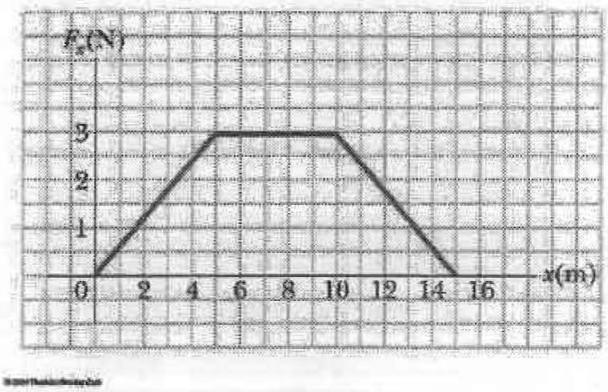

Figure 4 *[Rajah 4]*

(iv) In the neck of the picture tube of a certain black-and-white television set, an electron gun contains two charged metallic plates 2.80 cm apart. An electrical force accelerates each electron in the beam from rest to 9.60% of the speed of light over this distance. (a) Determine the kinetic energy of the electron as it leaves the electron gun. Electrons carry this energy to a phosphorescent material on the inner surface of the television screen, making it glow. For an electron passing between the plates in the electron gun, determine (b) the magnitude of the constant electrical force acting on the electron, (c) the acceleration, and (d) the time of flight.
[Di leher sebuah tiub gambar television hitam-putih, sebuah senapang elektron mengandungi dua plat metalik bercas dipisahkan 2.80cm antara satu sama lain. Daya elektrik memecutkan setiap electron dalam alur dari rehat kepada suatu laju sebanyak 9.60% laju cahaya sepanjang jarak tersebut. (a) Tentukan tenaga kinetik elektron apabila meninggalkan senapang. Elektron membawa tenaga ini kepada bahan fosforesen yang terdapat pada permukaan dalam skrin television dan menyebakan ianya bersinar. Untuk setiap elektron yang melalui kedua plat, tentukan (b) magnitud daya elektrik malar yang bertindak ke atas electron, (c) pecutan, dan (d) masa yang diambil oleh setiap elektron dalam perjalanan di antara kedua plat.]

(40/100)

4. (i) The coefficient of friction between the 3.00-kg block and the surface in Figure 5 is 0.400. The system starts from rest. What is the speed of the 5.00-kg ball when it has fallen 1.50 m?
[Pekali geseran di antara blok 3.00kg dan permukaan dalam Rajah 5 ialah 0.400. Sistem bermula dari keadaan rehat. Apakah kelajuan bola 5.00kg apabila ianya telah jatuh sebanyak 1.50m ke bawah?]

(20/100)

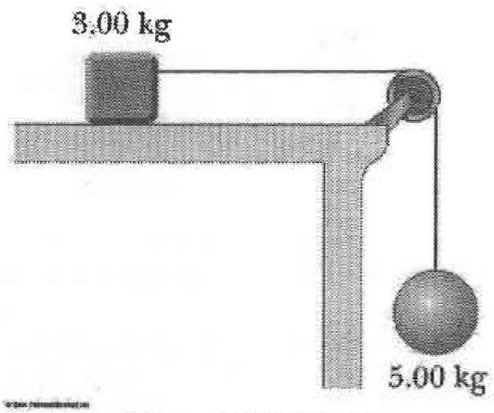

Figure 5 *[Rajah 5]*

(ii) Two shuffleboard disks of equal mass, one orange and the other yellow, are involved in an elastic, glancing collision. The yellow disk is initially at rest and is struck by the orange disk moving with a speed of 5.00 m/s. After the collision, the orange disk moves along a direction that makes an angle of 37.0° with its initial direction of motion. The velocities of the two disks are perpendicular after the collision. Determine the final speed of each disk.
[Dua cakera berjisim sama, satu berwarna oren dan satu lagi berwarna kuning terlibat dalam perlanggaran kenyal. Cakera kuning asalnya berada dalam rehat dan dihentam oleh cakera oren yang bergerak pada kelajuan 5.00m/s. Selepas perlanggaran, cakera oren bergerak dalam arah yang membuat sudut 37.0° dengan arah asal. Halaju-halaju kedua cakera berserenjang selepas perlanggaran. Tentukan kelajuan akhir setiap cakera.]

(20/100)

(iii) Two blocks, as shown in Figure 6, are connected by a string of negligible mass passing over a pulley of radius 0.250 m and moment of inertia *I*. The block on the frictionless incline is moving up with a constant acceleration of 2.00 m/s^2. (a) Determine T_1 and T_2, the tensions in the two parts of the string. (b) Find the moment of inertia of the pulley.
[Dua blok dalam Rajah 6 dihubungkan oleh seutas tali dengan jisim yang boleh diabaikan. Tali melalui suatu takal yang berjejari 0.250m dengan momen inersia I. Blok di atas permukaan condong tiada geseran bergerak ke atas dengan pecutan seragam 2.00m/s^2. (a) Tentukan T_1 dan T_2, tegangan tali. (b) Cari momen inersia takal tersebut.]

(30/100)

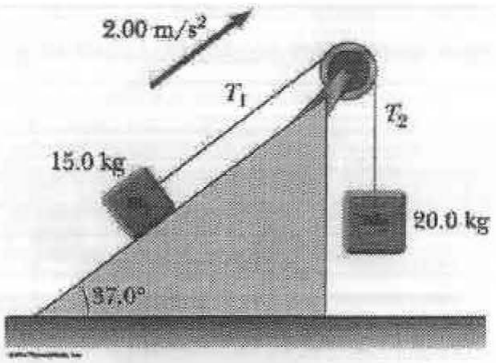

Figure 6 *[Rajah 6]*

(iv) A conical pendulum consists of a bob of mass m in motion in a circular path in a horizontal plane as shown in Figure 7. During the motion, the supporting wire of length ℓ maintains the constant angle θ with the vertical. Show that the magnitude of the angular momentum of the bob about the center of the circle is

[Bandul kon mengandungi ladung berjisim m bergerak dalam laluan membulat dalam satah mengufuk seperti dalam Rajah 7. Semasa pergerakan, wayar sepanjang l memastikan ladung membuat sudut θ dengan garis menegak. Tunjukan bahawa magnitud momentum sudut ladung di sekitar pusat bulatan diberi sebagai

$$L = \left(\frac{m^2 g \ell^3 \sin^4 \phi}{\cos \phi} \right)^{1/2}$$

(30/100)

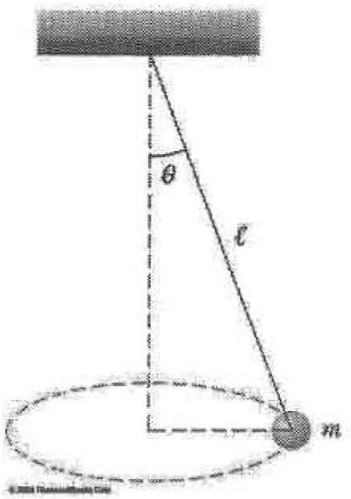

Figure 7 [*Rajah 7]*

5. (i) One end of a uniform 4.00-m-long rod of weight F_g is supported by a cable. The other end rests against the wall, where it is held by friction, as in Figure 8. The coefficient of static friction between the wall and the rod is $\mu_s = 0.500$. Determine the minimum distance x from point A at which an additional weight F_g (the same as the weight of the rod) can be hung without causing the rod to slip at point A.

[Suatu rod 4.00m dengan berat F_g disokong oleh suatu kabel pada hujungnya. Hujung satu lagi disandarkan pada dinding melalui suatu daya geseran seperti dalam Rajah 8. Pekali geseran statik antara dinding dan rod ialah $\mu_s = 0.500$. Tentukan jarak minimum x dari titik A di mana berat tambahan F_g (sama berat dengan rod) boleh digantung tanpa menyebabkan rod tergelincir pada titik A.]

(20/100)

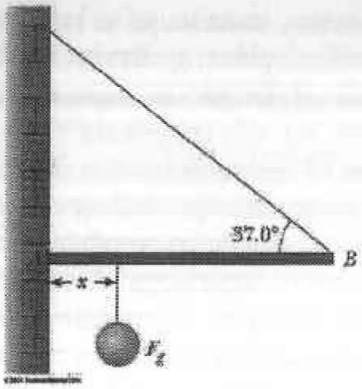

Figure 8 [*Rajah 8*]

(ii) Three objects of equal mass are located at three corners of a square of edge length ℓ as in Figure 9. Find the gravitational field at the fourth corner due to these objects.
[Tiga objek berjisim sama terletak pada tiga penjuru segiempat sama dengan panjang ℓ seperti dalam Rajah 9. Cari medan graviti pada penjuru keempat yang disebabkan oleh ketiga-tiga objek tersebut.]

(10/100)

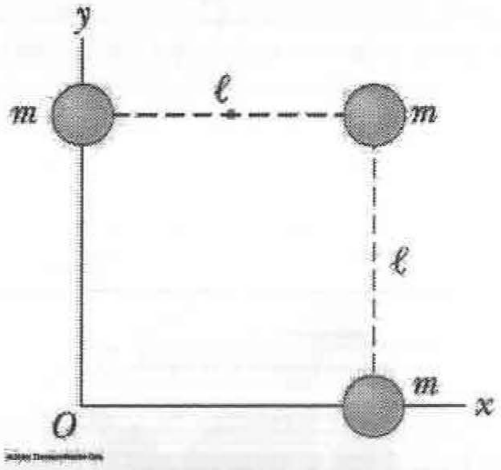

Figure 9 [*Rajah 9*]

(iii) A satellite of mass 200 kg is placed in Earth orbit at a height of 200 km above the surface. (a) With a circular orbit, how long does the satellite take to complete one orbit? (b) What is the satellite's speed? (c) What is the minimum energy input necessary to place this satellite in orbit? Ignore air resistance but include the effect of the planet's daily rotation.
[Suatu satelit berjisim 200kg terletak pada orbit bumi setinggi 200km dari permukaan bumi. (a) Berapa lamakah diperlukan untuk satelit melengkapkan satu orbit membulat? (b) Apakah kelajuan orbit? (c) Apakah tenaga minimum diperlukan untuk meletakkan satelit pada orbitnya? Abaikan rintangan udara.]

(30/100)

(iv) A U-tube of uniform cross-sectional area, open to the atmosphere, is partially filled with mercury. Water is then poured into both arms. If the equilibrium configuration of the tube is as shown in Figure 10, with $h_2 = 1.00$ cm, determine the value of h_1.
[Suatu tiub U dengan keratan rentas seragam, terbuka kepada atmosfera, sebahagiannya diisi dengan raksa. Air kemudiannya dimasukan ke dalam kedua-dua lengannya. Jika keadaan keseimbangan adalah seperti dalam Rajah 10, dengan h_2=1.00cm, tentukan h_1.]

(10/100)

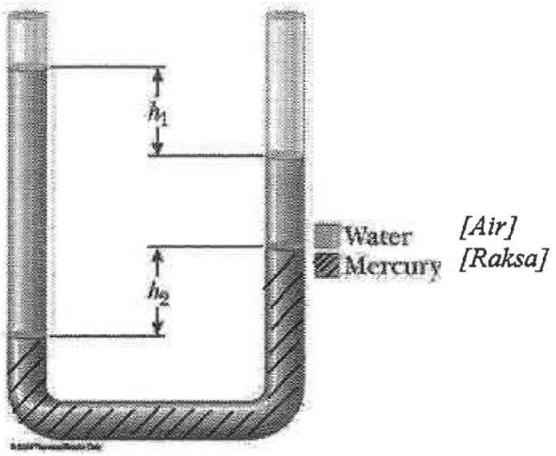

Figure 10 *[Rajah 10]*

(v) A 50.0-g object connected to a spring with a force constant of 35.0 N/m oscillates on a horizontal, frictionless surface with an amplitude of 4.00 cm. Find (a) the total energy of the system and (b) the speed of the object when the position is 1.00 cm. Find (c) the kinetic energy and (d) the potential energy when the position is 3.00 cm.
[Objek 50.0g disambung pada suatu spring dengan pemalar daya 35.0 N/m mengayun di atas permukaan mengufuk yang tiada bergeseran dengan amplitud ayunan 4.00cm. Cari (a) jumlah jumlah sistem ini (b) kelajuan objek pada kedudukan 1.00cm. Cari (c) tenaga kinetik dan (d) tenaga keupayaan pada kedudukan 3.00cm.]

(20/100)